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STATE PLANNING FOR HIGHER EDUCATION AND JOBS IN AN AGE OF HIGH TECHNOLOGY

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Abstract

As states enter an age of high technology, they are confronted with the challenge of ascertaining future job needs and the appropriate educational response to preparing a work force for those jobs. This paper presents an analysis of the implications of high technology in the job market and the challenges to states for both job creation and higher education. It asserts that states should take an active role in setting out both job and educational policies that meet their special needs. Specific suggestions are made for the pursuit of both economic and higher educational policies.

Introduction

Along with the nation as a whole, each of the states is entering an age of high technology. High technologies generally refer to the development and use of computers, lasers, communications technologies, information technologies, robotics, and bio-engineering technologies in the economy. Since these technologies are so closely associated with research and development activities, they are often thought to be heavily dependent upon workers with advanced education and training. Indeed, the media are warning that as we move towards a high technology society, there may well be an impending bottleneck in the labor force if we do not upgrade substantially the education of the population. This contention is based upon the view that traditional industries are being replaced by ones that use the new technologies, and the new job requirements will entail higher levels of sophistication than those of the old jobs. Some pundits even predict the demise of entry-level jobs requiring little education.

One obvious issue is the role of higher education. Will the new technologies require an unprecedented expansion and renovation of higher education to meet the new challenges? If so, what specifically should be done? The purpose of this presentation is to address these issues by asking where the new jobs will be and what types of policy responses in both the economy and in higher education make sense.

Where Will the Jobs Be?

In considering where the jobs will be and their educational requirements, we must avoid two fallacies that are reflected in

popular discussions on the subject. First is the fallacy that equates "high technology" industries with jobs that require high skill levels and advanced education. Second is the fallacy that assumes that the fastest growing job categories in terms of relative growth or percentage growth are also the ones that will provide the most new jobs in the future.

The question of what is a high technology industry is very much open to debate. The U.S. Department of Labor uses three definitions (Riche, Hecker, and Burgan, 1983): (1) Those industries in which technology-oriented workers (engineers, scientists, etc...) accounted for a proportion of total employment that was at least one and a half times the average for all industries; (2) Those industries in which the ratio of R. & D. expenditures to net sales was at least twice the average for all industries; and (3) A combination of criteria (1) and (2). Even when these industries were singled out, only a relatively small portion of jobs in such high tech industries required high tech workers in terms of skills and educational requirements. For example, in electronic components firms, only about 15 percent of the jobs were technologically oriented, while 61 percent were blue collar jobs (Riche, Hecker, and Burgan, 1983:54). What we often tend to forget is that firms that are selling products must hire large numbers of assemblers, clericals, warehouse workers, secretaries, and so on. Even the computer and data processing industry had only one-quarter of its labor force in technically-oriented positions (Riche, Hecker, and Burgan, 1983:54). For the automobile industry, the percentage of such positions was less than 6 percent (Riche, Hecker, and Burgan,

1983:54). The growth of high technology industries does not mean that all or most of the new jobs that will be created will require high levels of technical skills. Most new jobs in these industries will require high school diplomas rather than advanced education and training.

Thus, the concern over education should really focus on the expansion of jobs in high technology occupations and in other higher level occupations, rather than in so-called high technology industries. The most sophisticated job projections have been carried out by the U.S. Department of Labor, Bureau of Labor Statistics (BLS). The BLS has been making such forecasts for almost forty years and has been refining its methods based upon evaluations of the projections with the actual outcomes. The BLS method takes account of alternative economic growth rates, technological change as it affects occupational requirements and production techniques, and a wide variety of other criteria (Rumberger and Levin, 1984). Table One shows the forty occupations with the largest expected job growth from 1982-95 (Silvestri, Lukasiewicz, and Einstein, 1983:45). The top five occupations in terms of the numbers of jobs projected are building custodians, cashiers, secretaries, general office clerks, and sales clerks.

No high technology occupations are included among the top 18 expected to contribute the most jobs to the American economy. Although fast food workers, guards and doorkeepers, kitchen helpers, and janitors are reflected among the top occupations, high tech occupations are far down the list. While it is expected that some 200

thousand additional computer programmers will be needed by 1995, the growth in jobs for building custodians, fast food workers, and kitchen helpers is expected to be more than 1.3 million. The point is that most job growth will be in areas requiring high school completion or less or some community college training. Relatively few jobs will require the skills of a college graduate or post-graduate training. The BLS estimates that only about a quarter of the 40 jobs with the largest expected contribution to job growth will require a college degree.

But, how can these results be reconciled with the persistent messages that high technology jobs are the ones growing most rapidly and that the educational requirements for these jobs will be high? Part of the answer is that, in percentage or relative terms, many of the occupations with the most rapid growth rates are in high technology occupations as shown in Table Two. But, although these job categories are growing at a rapid rate in relative terms, this growth occurs in occupations with numerically small numbers, so that rapid growth rates produce relatively few new jobs. For example, although employment of computer systems analysts is expected to rise by about 85 percent during the 1982-95 period, only about 200,000 new jobs are expected to emerge from this growth.

A second explanation for the puzzle is the assumption that high tech jobs all require advanced education. Although it is projected that the number of jobs for computer operators will rise by 76 percent during this period, it should be recognized that those jobs typically require no education beyond high school completion. This is also true

of the increasing number of computer and micro-processor repair positions which use highly sophisticated diagnostic equipment that automatically identifies the problems and simple component and circuit-board construction that enables component replacement with little sophistication.

The BLS has defined high technology occupations to include engineers, life and physical scientists, mathematical specialists, engineering and science technicians, and computer specialists (Riche, Hecker, and Burgan, 1983:54-55). Workers in these occupations typically need advanced training at an associate degree level at a minimum and up through the doctorate in some cases. Although the growth of these occupations will be at a rate about twice that of all wage and salary workers, the actual number of jobs expected to emerge will be about 1.5 million new jobs out of an expected 23-28 million new jobs. It is expected that only about 6 percent of the new jobs in the economy will be in high technology occupations, about the same proportion as in the 1970's (Riche, Hecker, and Burgan, 1983).

But, what of the effects of high technology on other occupations? Will high technology require increased skills in those occupations? The available evidence suggests that the principal impact of micro-processors and robotics on traditional occupations will be to displace some workers and to reduce the skills of other workers. This conclusion is consistent with the work on machine automation done in earlier periods where it was found that new production technologies tend to reduce skill requirements (Bright, 1958; Levin and Rumberger, 1983). This is also logical, since an investment in new capital can

only be profitable if it reduces overall costs for any given output. Reduced labor costs can be derived from using fewer people in the production process, using persons with lower skill levels and wages, or some combination of these. It is the latter that seems most applicable, as our analysis of the application of computers and robots suggests. Let me provide a few examples.

Secretaries are being replaced by word processors at a very rapid rate. Traditionally, secretaries had to know the appropriate formats for reports and correspondence and had to be almost letter-perfect in their typing skills. In addition, they needed strong spelling skills and a basic understanding of grammatical usage. However, word processors can correct typing errors automatically, so letter-perfect typing and strong spelling are no longer required. Formats for different types of documents can be programmed into the word processor, and even grammatical revisions can be done through syntactical programs. The result is that many of the traditional functions of the secretary have been replaced by the machine. It should also be noted that the increased productivity of word-processing reduces the need for office workers. Moreover, the shift from a typewriter to a word-processor requires relatively little training. One of the major suppliers of temporary manpower has found that it can prepare typists who lack background on word processing equipment with only one day of intensive instruction.

A second example is found in the field of computer programming. Not only were earlier computers larger and more expensive than today's computers, but they were far more cumbersome to program. The power of

the technology itself has displaced much of the earlier skills required of the programmer with the transition from circuit logic and plug boards to machine language, macro-assembly languages, scientific and business-oriented user languages, and the relatively simple languages that are in use today. In increasing numbers of cases, powerful software packages enable highly sophisticated applications to broad classes of problems, with the programmer only required to provide data and select from among a menu of options. And, even present programming languages will be replaced with "natural" languages--the language of the user-- simple mechanical devices such as the computer "mouse", and voice recognition. Although a small number of programmers using the state-of-the-art will require very sophisticated skills, the average programmer will not, and software will replace programmers.

Similar stories can be told for computer and computerized machine repair, data processing, auto repair, design, drafting, and many other occupations. Just as a modern automobile with six or seven micro-processors requires far less skill to drive than a primitive Model T, the vast majority of high technology applications enable a reduction in the skill requirements of the operator. Many workers will be displaced by the new technologies, and far more will see their jobs reduced to ones requiring minimal training and skills. As a portent of this, we should be aware that many American multi-national firms are producing much of their outputs of sophisticated silicon chips in such third world countries as Malaysia, where young women

from rural areas with a few years of primary education have displaced American assembly workers.

What Should Be Done

The advent of high technology will increase the capabilities of the economy, reduce prices, offer a large array of new products, and contribute in other ways to our society. Yet, contrary to popular reports, it is not likely to add large numbers of jobs for highly educated and trained persons; it is likely to displace substantial numbers of workers; and it appears to be reducing the skill requirements of broad classes of traditional occupations. What should be done?

General Policies

1- It is clear that we can not rely on high technology to solve the employment problem. Such reliance has actually undermined traditional jobs by ignoring the large number of jobs--even in smoke-stack industries--that are necessary to our economy and that can be saved through judicious policy. First, we must examine which jobs in declining industries, beset by foreign competition, are worth saving and what will be the cost. In many cases, high technology will be part of the solution, since major investments in high technologies can increase productivity enormously. It is absurd to think that the U.S. will produce only information services, computer software, and research and development, and that all of our other goods and services will be imported from lower cost, third world countries. This is the silly vision of some futurists. We will continue to be a major

manufacturer of steel and metal products, automobiles, machine tools, and many other basic products. The question is how we can improve our performance and compete more effectively in both domestic and world markets, not how we pursue the purposive abandonment of such industries.

2- Most new jobs are created in small and medium-size firms rather than in the large corporations or in government (Armington, 1983; Greene, 1982; Richman, 1983). To the degree that Fortune 500 firms have increased employment, it has been done largely through acquisitions and foreign subsidiaries. Many of the largest corporations have been reducing employment over the long run while expanding output through labor-saving approaches. Accordingly, we must promote entrepreneurship and the establishment and survival of substantial numbers of smaller businesses. Such businesses not only have greater employment potential, but they also are the major incubators for product innovation in America (U.S. Small Business Administration, 1983:Chapter 5). Government assistance should be provided in the form of technical help, information on markets, and successful attempts to reduce interest rates. Present national deficits and other aspects of national economic policy have kept interest rates high, and this is the largest single enemy of small businesses.

3- The family farm is still the most efficient building block of American agriculture. This has been one of the most consistent findings in the literature on agricultural economics. Such farms are more productive in terms of total factor inputs, and they provide considerably more employment per unit of investment than the large corporate entities. Yet, agricultural policy--and particularly high

interest rates--are undermining the family farm while providing the largest benefits from tax policies, agricultural subsidies, and water subsidies (particularly in the West) to the wealthiest corporations in America. Clearly, a more even-handed policy is in order or one that promotes the family-type farm (Humphries, 1980). Such farmers need assistance in terms of access to credit as well as in the application of high technologies that will keep them competitive. This is another area in which overall employment can be maintained or increased.

4- In order to compete better in world markets, we need to have a much more aggressive policy to promote trade. Businesses need more information in a convenient form about foreign markets and the requirements for entering and competing in them. They need assistance at the state level with respect to where the opportunities will be and how to take advantage of them. None of this will easily overcome a strong dollar which makes American goods expensive to foreigners. However, as interest rates come down over the longer run, we must be in a position to exploit the resulting improvement in the attractiveness of U.S. prices to foreign purchasers. Even under existing exchange rates we can generate much more employment in the foreign trade sector.

5- Finally, we need to capitalize on educationally-intensive types of activities. Much of the Japanese successes have been built on continually upgrading the workforce and creating technological change in materials and capital-saving forms rather than labor-savings ones. For example, of process innovations initially introduced between 1945 and 1974, some 61 percent of those introduced in the U.S. were

labor-saving as compared with only 16 percent of those introduced in Japan and 18 percent of those introduced in Europe (Davidson, 1976). In contrast, only about 19 percent of such innovations introduced in the U.S. were material saving in comparison with about half in Japan and Europe. Yet, both Japan and Western Europe increased their labor productivity considerably more than the U.S did over this period, despite their failure to adopt labor saving devices at the rate of the Americans. Other examples, of industrially competitive organizations with high labor inputs are the producer cooperative movement of Mondragon in Spain that has produced over a billion dollars a year of industrial and high technology products with far greater labor inputs and higher productivity than comparable firms organized in traditional ways. We must do much more to explore the possibilities of efficient production organizations with high labor inputs and highly trained workers (Levin, 1983).

Educational Policies

1- It is clear that the structure of American industry is changing dramatically with massive repercussions for the workforce. Many workers will be displaced and will need new training to acquire another job, while others will need to be retrained to accommodate new technologies. Retraining does not mean that higher level skills will be needed as much as different ones. In some cases the training will take hours or days, while in other cases the need will be for weeks, months, or even years. A policy of recurrent education must be established to make it easily possible for individuals to move from

the workplace to retraining programs and back into the workplace, a system in which education and work follow a recurring pattern. At the present, there are large numbers of federal, state, local, and privately sponsored programs with employers, school districts, community colleges, unions, proprietary schools, universities, and local training entities providing educational and training services. Sources and modes of finance are also highly fragmented. The challenge is to construct an overall system of recurrent education and finance that will be efficient, responsive, and that will draw upon all elements of the post-secondary educational system (Levin and Schutze, 1983).

2- The jobs that will be available to any individual over a lifetime as well as the ones that he or she will find attractive are unpredictable. While job projections can give us some idea of the array of employment opportunities that will be available at a future time, they can not tell us precisely what will be available and what skills will be required for any particular individual situation. Accordingly, I believe that it is important to stress a broad array of fundamental skills in higher education for the vast majority of students--rather than narrow vocational preparation. These skills include written and oral expression, mathematics, sciences, fine and performing arts, analytical skills, social sciences, and foreign languages. These will provide a firm basis for obtaining the applied training that will be needed at each stage of the career.

3- Much more emphasis should be placed on the training of entrepreneurs and on the formation of creativity in virtually all of

higher education. This can be done by restructuring courses and curricula to provide greater analytic work in creative solutions to problems as well as providing greater incentives for imaginative solutions in contrast to rote learning. We should also provide incentives and encouragement for greater risk-taking among our students in the subjects that they take, in the nature of the assignments that they do, and in the careers that they pursue. I am convinced that much improvement in the entrepreneurial capabilities of the population can be effected in our colleges and universities.

4- Finally, the abysmal knowledge of foreign languages and cultures does not augur well for our successful competition in world markets. Virtually all students in higher education should be required to obtain proficiency in at least one foreign language and culture, and much of the curriculum should reflect cross-cultural rather than narrow egocentric thinking. If we cannot communicate with and think like people in other cultures, it is unlikely we will respond to their needs and get their business. There is much to do on this front.

A Concluding Remark

The picture that I have painted of the implications of high technology for jobs and higher education is not a bright one. That is, it is not bright if we simply assume that the high technology revolution will provide plenty of jobs for highly trained individuals. However, we can do something about it through conscious choices in both the economic arena and the educational one. Ignoring the problem will lead to serious consequences for both the labor force and the educational sector.

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TABLE ONE

Forty occupations with largest job growth, 1982–95

Occupation	Change in total employment (in thousands)	Percent of total job growth	Percent change
Building custodians	779	3.0	27.5
Cashiers	744	2.9	47.4
Secretaries	719	2.8	29.5
General clerks, office	696	2.7	29.6
Salesclerks	685	2.7	23.5
Nurses, registered	642	2.5	48.9
Waiters and waitresses	562	2.2	33.8
Teachers, kindergarten and elementary	511	2.0	37.4
Truckdrivers	425	1.7	26.5
Nursing aides and orderlies	423	1.7	34.8
Sales representatives, technical	386	1.5	29.3
Accountants and auditors	344	1.3	40.2
Automotive mechanics	324	1.3	38.3
Supervisors of blue-collar workers	319	1.2	26.6
Kitchen helpers	305	1.2	35.9
Guards and doorkeepers	300	1.2	47.3
Food preparation and service workers, fast food restaurants	297	1.2	36.7
Managers, store	292	1.1	30.1
Carpenters	247	1.0	28.6
Electrical and electronic technicians	222	.9	60.7
Licensed practical nurses	220	.9	37.1
Computer systems analysts	217	.8	85.3
Electrical engineers	209	.8	65.3
Computer programmers	205	.8	76.9
Maintenance repairers, general utility	193	.8	27.8
Helpers, trades	190	.7	31.2
Receptionists	189	.7	48.8
Electricians	173	.7	31.8
Physicians	163	.7	34.0
Clerical supervisors	162	.6	34.6
Computer operators	160	.6	75.8
Sales representatives, nontechnical	160	.6	27.4
Lawyers	159	.6	34.3
Stock clerks, stockroom and warehouse	156	.6	18.8
Typists	155	.6	15.7
Delivery and route workers	153	.6	19.2
Bookkeepers, hand	152	.6	15.9
Cooks, restaurants	149	.6	42.3
Bank tellers	142	.6	30.0
Cooks, short order, specialty and fast food	141	.6	32.2

Note: Includes only detailed occupations with 1982 employment of 25,000 or more. Data for 1995 are based on moderate-trend projections.

Source: Silvestri *et al.* 1983:45

TABLE TWO

Twenty fastest growing occupations, 1982–95

Occupation	Percent growth in employment
Computer service technicians	96.8
Legal assistants	94.3
Computer systems analysts	85.3
Computer programmers	76.9
Computer operators	75.8
Office machine repairers	71.7
Physical therapy assistants	67.8
Electrical engineers	65.3
Civil engineering technicians	63.9
Peripheral EDP equipment operators	63.5
Insurance clerks, medical	62.2
Electrical and electronic technicians	60.7
Occupational therapists	59.8
Surveyor helpers	58.6
Credit clerks, banking and insurance	54.1
Physical therapists	53.6
Employment interviewers	52.5
Mechanical engineers	52.1
Mechanical engineering technicians	51.6
Compression and injection mold machine operators, plastics	50.3

Note: Includes only detailed occupations with 1982 employment of 25,000 or more. Data for 1995 are based on moderate-trend projections.

Source: Silvestri et al. 1983:46